HOW TO CONSTRUCT AN INDEPENDENT INTERRUPTER.*

By A. FREDERICK COLLINS.†

IT is usually not an easy task that confronts the amateur constructor of a large induction coil when he reaches a point in his work where he must choose the type of interrupter he intends to use.

While the mercury turbine and electrolytic interrupters are a great deal more effective than a vibrating spring interrupter of the best type, yet the former devices are more complicated and require constant attention. The independent multiple interrupter is the next best instrument and, indeed, many operators prefer it, for, while the highest efficiency is not secured by its use, it possesses the compensating features of being simple, always ready, requires practically no attention in adjustment, and gives excellent results. Moreover, it may be applied to coils of all sizes giving a four-inch spark or over, and can be operated on a battery or 110-volt direct-current circuit with equal facility.

The term "independent multiple interrupter" is used to indicate that this make-and-break device is complete in itself, although it forms a subsidiary piece of apparatus of the completed coil. In the type under consideration a vertical rod is secured to the free end of the shunt-circuit vibrating spring, and this carries a sliding weight retained in position by a set screw; by moving the weight along the rod the period of vibration may be varied within certain limits; hence the word "multiple" is used to distinguish it from those interrupters whose periods of vibration are fixed.

The independent interrupter to be described embodies all the improvements of the double spring interrupter, and being operated by a shunt circuit it may be started or stopped as desired and the current flowing through the primary coil made or broken or intermittently interrupted, as the specifications of some wireless telegraph systems call for. Other good points in favor of this interrupter are; that its action is independent of the heavy current flowing through the coil, it gives a clean-cut and exceedingly sharp break, and it cannot stick.

The individual parts of the independent interrupter are shown in Fig. 1, the sizes of which may be obtained by referring to the following table.

When all the above parts have been prepared the interrupter is ready to be assembled. To one end of the main contact spring, which is the thin one (see Figs. 2 and 3), the iron plate is secured by means of a ⅛-inch screw and a nut 3/16 inch thick; the length of the screw is such that the nut projects 3/32 inch over its end and into this is screwed and soldered the platinum contact point. A small screw passes through the spring and into the plate to keep the latter from turning; this leaves the end of the plate with the large hole projecting above the end of the spring, while the opposite end is screwed to its brass support and the latter to the hard-rubber base; it should be set at a distance of 2¼ inches from one end of the latter and 1½ inches from either side.

*Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

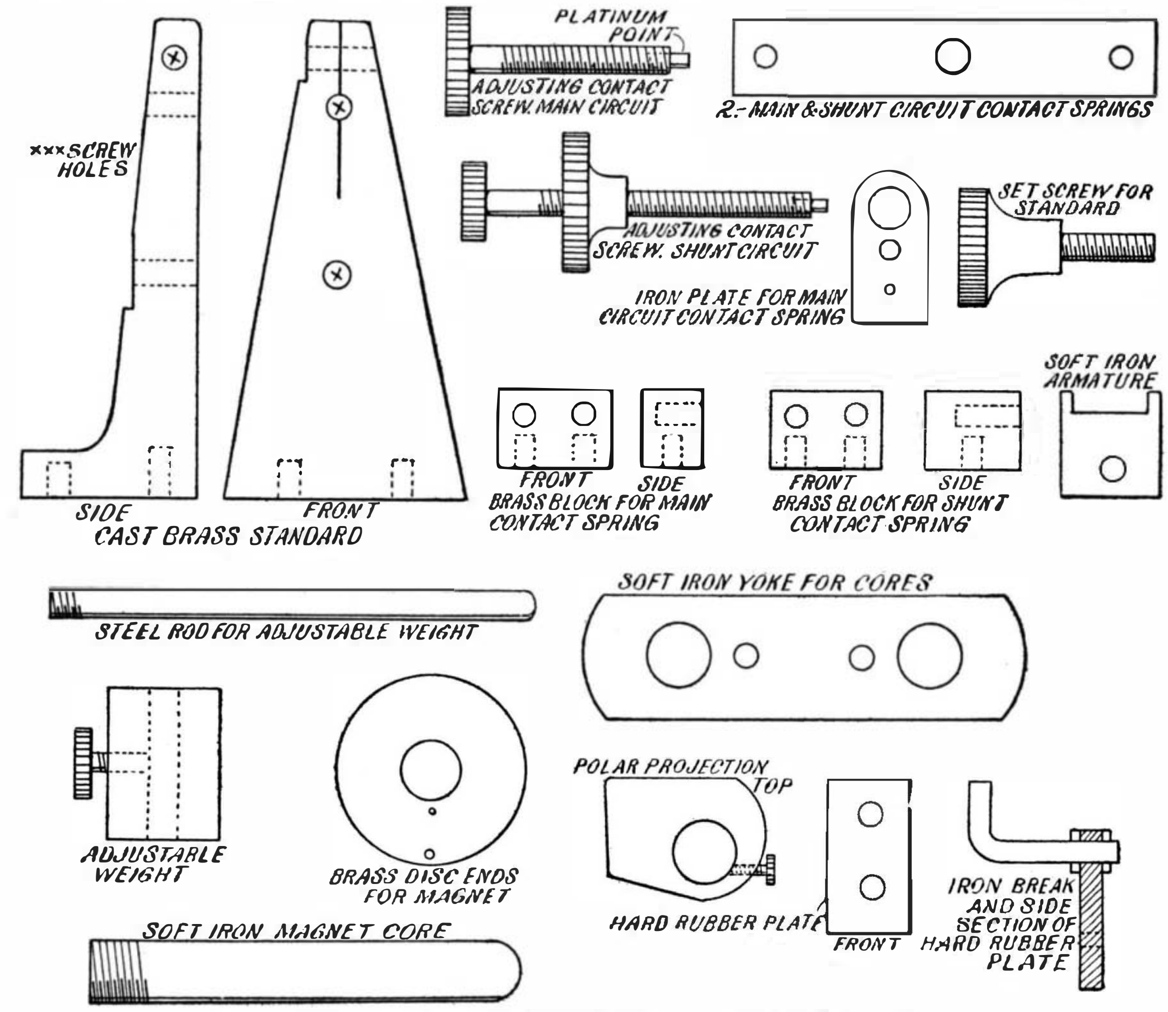


FIG. 1.—PARTS OF THE INDEPENDENT INTERRUPTER.

The shunt circuit spring, which is the thick one, is placed in the groove of the cubical armature and on the opposite side of the spring, and likewise mounted in the groove with it is the hard-rubber plate when the three pieces are screwed together. The bent iron break rod with a stop nut screwed on it 5/16 inch is then inserted through the upper hole in the hard rubber plate, which projects above the armature, and this is rigidly attached by a nut on the opposite side. In the top of the armature is screwed the brass rod for carrying the adjustable weight. The lower end of the spring is then screwed to its brass block support and the latter in turn to the hard rubber base, when the spring should set ½ inch in front of the shunt circuit spring or 2¾ inches from the front end. To the screw holding the support of the spring to the base a few inches of insulated wire, about No. 16, is connected, as this is a portion of the shunt circuit.

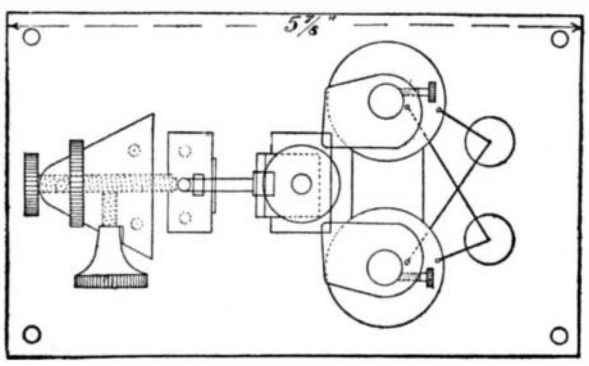


FIG. 2.—PLAN OF INDEPENDENT INTERRUPTER.

The standard is secured to the base by two screws, and the face of this should be exactly ½ inch back of the main circuit contact spring or 2 inches from the front of the base. To one of the screws underneath the base a No. 12 insulated wire is attached having a length of several inches, for both the main and shunt circuits currents pass through it. Into the extreme upper hole on the side of the standard the set-screw is inserted and in the hole just below and at right angles to it is screwed the adjusting contact screw of the main circuit break. Into the lower hole

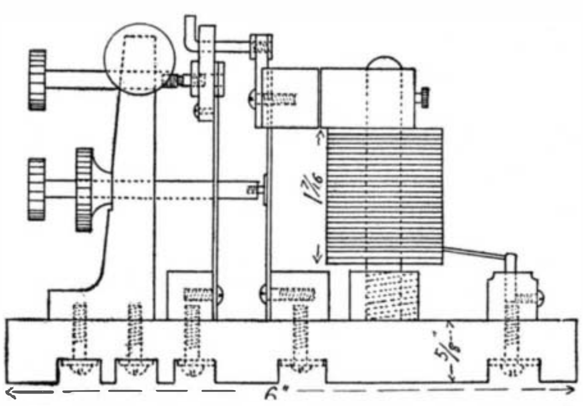


FIG. 3.—SIDE ELEVATION OF INDEPENDENT INTERRUPTER.

TABLE OF SIZES OF INTERRUPTER PARTS.

1	Cast Brass Standard	Height 3 ins.	Dimensions front and rear elevations top ¼ in.	Dimensions front and rear elevations base 1⅛ ins.	Dimensions side elevation top ⅜.	Dimensions side elevation base 1⅛ ins.	3/16-in. hole drilled and tapped from face to back ½ in. from top. Ditto 1½ in. from base; ⅛-in. hole drilled and tapped through on side ¼ in. from top. Three ⅛-in. holes drilled and tapped in surface of base.
2	Adjusting contact screw for main circuit	Length ⅛ in.	Diam. 3/16 in.	Diam of milled head ⅝ in.	Diam. of check nut ⅞ in.	....	End drilled and tapped out and platinum point screwed in.
3	Platinum contact points for adjusting screws	For main circuit scr'w diam. ⅛ in.	For main circuit scr'w length ¼ in.	For shunt circuit scr'w diam. 3/16 in.	For shunt circuit scr'w length 1/16 in.		
4	Adjusting contact screw for shunt circuit	Length 2¼ in.	Diam. 3/16 in.	Diam. of milled head ⅛ in.	Diam. of check nut ⅞ in.		
5	Main circuit contact spring	Length 2¼ in.	Width ⅛ in.	Thickness 1/64 in.	....	....	⅛-in. hole drilled and tapped ¼ in. from each end; ¼-in. hole cut out 1⅛ in. from bottom.
6	Iron plate for main circuit contact spring	Length 1 in.	Width ⅛ in.	Thickness 3/32 in.	....	....	Rounded top; ¼-in. hole drilled ¼ in. from top; ⅛-in. hole drilled and tapped 9/16 in. from top; 1/16-in. hole drilled and tapped 3/16 in. from bottom.
7	Set screw for standard	Length of screw ⅝ in.	Diam. of screw ⅛ in.	Diam. of milled head ¾ in.	Total length 1¼ in.	....	Screw is turned with a shoulder.
8	Shunt circuit contact spring	Length 2¼ in.	Width ⅛ in.	Thickness 1/32 in.	....	....	⅛-in. hole drilled ¼ in. from each end; platinum contact disk soldered to spring 1⅛ in. from bottom.
9	Brass block for main contact spring	Length ¾ in.	Width ⅛ in.	Thickness ⅛ in.	....	....	⅛-in. hole drilled and tapped in center of side. Ditto in bottom.
10	Brass block for shunt contact spring	Length ¾ in.	Width ⅝ in	Thickness ⅛ in.	....	....	⅛-in. hole in side and bottom as above.
11	Soft iron armature	Length ⅝ in.	Width ⅝ in.	Thickness ⅝ in.	....	....	Slotted to depth ⅛ in. on one side ⅛ in. wide to receive spring; ⅛-in. hole drilled in center of slotted side; 3/16-in. hole drilled and tapped in top 3/16 in. of edge opposite slot.
12	Steel rod for sliding weight	Length 8 in.	Diam. 3/16 in.				
13	Sliding weight	Length 1 in.	Diam. ¾ in.	....	....	....	3/16-in. hole drilled longitudinally through center; ⅛-in. hole drilled and tapped at right angles to above hole; this is for set screw.
14	Soft iron magnet cores (2)	Length 2¼ in.	Diam. ⅝ in.	....	....	....	One end threaded; opposite end rounded.
15	Brass disk ends for magnet cores (4)	Outside diam. 1¼ in.	Diam. of aperture ⅝ in.	Thickness 1/16 in.	Distance from core ends, tapped end ⅝ in.	Distance from core ends, rounded end ¾ in.	1/32-in. holes drilled in two lower disks; first within 1/32 in. of aperture, second same distance from circumference.
16	Soft iron yoke for cores	Length 2⅝ in	Width ¾ in.	Thickness ⅛ in.	....	....	Holes drilled and tapped ⅝ in. from each end to receive magnet cores; ⅛-in. holes near middle of screw yoke to base.
17	Polar projections	Length 1 in.	Width from ⅝ in at polar end to ¾ in. at rounded end.	Thickness ⅝ in.	Cross section of polar ends ⅝ x ⅝ in.	....	⅜-in. hole drilled through from top to bottom; ⅜-in. polar end; ⅛-in. hole drilled and tapped for set-screw in rounded end.
18	Magnet wire double cotton covered	No. 26.	Amount in ounces (approx.) 6	Number of turns (approx.) 1300			
19	Hard rubber plate for armature and shunt circuit	Length ⅞ in.	Width ⅛ in.	Thickness ⅛ in.	....	....	⅛-in. hole drilled 5/16 in. from bottom; ditto 3/16 in. from top.
20	Iron break rod	Length ¾ in.	Diam. ⅛ in.	....	....	....	Bent up ¼ in. from one end. End of longest portion threaded.
21	Hard rubber base	Length 6 in.	Width 3½ in	Thickness ½ in.			

the adjusting contact screw is inserted and screwed in so that it passes through the aperture in the main spring (but care must be taken that it clears the spring or otherwise the interruptor will be short-circuited) until it makes contact with the platinum disk soldered to the shunt circuit spring.

The yoke of the magnet is screwed to the base, it being assumed that the magnet coils have been wound. It may here be said that if double cotton-covered magnet wire is used there is no necessity for shellacing the layers. The cores of the magnet are screwed into the yoke and the polar projections slipped over the upper ends of the cores which should be adjusted so that when the spring carrying the armature is drawn to the cube of soft iron joining it, it will pass without touching either of the poles between them. This precludes the possibility of the armature sticking.

The binding posts are screwed into their respective holes in the end of the base, and from these underneath are connected terminals of No. 16 insulated wire. The terminals of the magnet between the coils and the posts are protected by rubber tubing and are connected in parallel instead of in series so that both ends of each coil are brought out and the two outer ends are connected to the posts nearest them while the two inner ends are crossed over and connected to the posts.

The interrupter is now ready to be connected with the inductor and source of electromotive force. Fig. 4 shows how these connections are made. The circuit from the battery or main line is led to the standard, the opposite side making connection with the thin spring carrying the heavy platinum points through

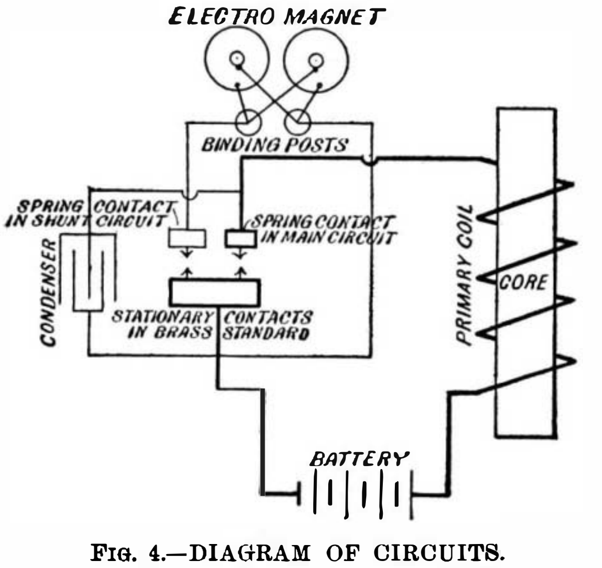


FIG. 4.—DIAGRAM OF CIRCUITS.

the primary winding of the coil. A shunt circuit leads off from the opposite side of the source of current, as shown in the diagram, and this includes the magnet coils and the light platinum contact on the heavy spring, the circuit being completed through the stationary contact carried by the lower screw of the standard.

The operation of the independent interrupter is simple. When the main and shunt circuits are open the movable and stationary contacts of both are closed; but when the current is turned on the magnet begins to pull the armature to its poles and by the time its cycle is one-fourth completed the bent end of the iron break rod attached to it strikes the iron plate of the main contact spring with the full force acquired through the pull of the magnet and its momentum, this action precluding the possibility of the platinum contacts striking, due to the welding of their surfaces by the heavy current. When the armature has pulled the shunt circuit contacts apart the elasticity of both springs brings the contacts together again, while the armature with its added weight above overshoots its normal vertical position, which on the return stroke again breaks the contacts.

To obtain the best results an adjustable condenser should be used in connection with the independent interrupter and is an important element in the proper working of the instrument, since different periods of interruption require varying values of capacity. For 10 and 12-inch coils mica condensers having a total capacity of 4 or 5 microfarads subdivided into fifths or tenths, preferably the latter, should be used, so that a suitable value may be had for all the different rates of interruption that the adjustable weight is capable of giving.

EXPERIMENTAL THEATER CONFLAGRATIONS.*

SOME very interesting experiments have been made in Vienna for the purpose of studying the phenomena of fires originating on the stage of a theater and determining the best methods of safeguarding the audience.

The experimental theater was constructed of steel concrete. The stage building is about 25 feet wide, 20 feet deep, and 25 feet high; the proscenium arch, 12 feet wide and 8½ feet high. Across the front of the stage extends a yard wide passage, separated from the stage by a wall having a large opening which can be closed by the ordinary drop curtain, and from the auditorium by a similar wall and the iron fire curtain. The stage has three doors communicating with the outer door, one at the back and one at each end of the passage. It also has four upper windows. In the center of the roof of the stage is a smoke outlet measuring about 3 by 8 feet, and in each corner is a sort of chimney, the combined area of the five openings being about one-eleventh the area of the stage.

The auditorium is 18 feet wide, 23 feet deep, and 15½ feet high. It communicates directly with the open air by a door on each side, near the stage. At the back is a gallery with a door at each end opening on external stairs. The back of the parterre, under this gallery, is separated from the front portion by a partition of steel concrete and wire glass behind which the observers of the experimental conflagrations can stand in safety. This observation chamber has a door opening on the street and another communicating with the body of the auditorium. In the roof of the auditorium is a smoke outlet about 3 feet square.

The theater is lighted by gas, candles, ordinary kerosene lamps, safety lamps, and electric bulbs.

In preliminary experiments automatic registering apparatus has indicated a maximum temperature of 750 deg. F. above the stage and maximum excesses over barometric pressure equivalent to 6.3 inches of water in the stage building and 5.5 inches in the auditorium when the curtains were raised, but all other openings in the auditorium were closed. This increase of pressure shattered the windows over the stage, and the glass was replaced by sheet iron. The pressure also raised the two valves of the cover of the smoke outlet in the roof of the stage, weighing 175 pounds each, but it did not prevent the perfect working of the iron curtain. Two small air holes in the walls near the floor of the stage facilitated a rapid spread of the fire.

After twenty-seven preliminary experiments had been made, the final experiments, five in number, were performed on November 22, 1905, in the presence of a committee of the Austrian Society of Engineers and Architects and a number of invited guests, including Count Kielmansegg, governor of the province of Lower Austria, through whose influence a grant of 12,000 crowns ($2,436) had been obtained from the imperial treasury for the prosecution of the work.

A quantity of "scenery" was provided, made of lath and paper soaked in a fire-retarding compound, with which the drop curtain was also impregnated. The chief fuel consisted of kindling wood which, together with the curtain and scenery, was saturated with petroleum. The fires were extinguished by a Vienna fire company armed with spraying nozzles, and in the last experiment an automatic Grinnell sprinkler over the stage also came into play. The conflagration could be watched from the observation chamber at the back of the auditorium and also through small windows, covered with fire-resisting glass, in the walls of the stage building.

The little experimental theater differs from real theaters in having no exterior corridors or lobbies. All the doors lead directly to the open air so that there is a strong indraft of cold air when they are opened. The fire, too, kindled more quickly and explosively than accidental fires usually do.*

First Experiment.—The conditions were made very unfavorable. All the outlets of the stage building were closed, while the outlet in the roof of the auditorium was half open. The drop curtain was down, the iron fire curtain raised. Gas, candles, kerosene, and electric lamps were lighted.

The burning of the combustible material on the stage developed, rapidly and explosively, a pressure which blew the bottom of the curtain far out into the auditorium. The insufficiency of air caused the combustion to be incomplete, and dense opaque smoke filled the auditorium as well as the stage. Burning fragments of wood and of the curtain were carried by the draft to the back of the auditorium. The increased atmospheric pressure, exceeding the pressure in the mains, at once extinguished the gas jets, and the deficiency of oxygen soon smothered the candles and kerosene lamps. The electric lights continued to glow, but their light was so obscured by the smoke that an audience would have been unable to find the exits and would certainly have been suffocated.

The observers of the experiments stood in the observation chamber, behind the fireproof partition.

Second Experiment.—The conditions remained as before, except that there was no inflammable curtain and the iron curtain was lowered after the fire on the stage was well started. As the smoke and gases could not escape in any other way they poured into the auditorium under the fire curtain in a stream that increased in force as the curtain descended, so that finally a jet of flame, 10 feet long, protruded into the auditorium, accompanied by a shower of blazing splinters. These phenomena ceased when the bottom of the iron curtain reached the stage. As before, the observers stood behind the partition.

Third Experiment.—Both curtains remained raised and the outlet in the auditorium tightly closed, while all the outlets in the roof of the stage were opened immediately after the fire was started.

These outlets carried off the smoke so well that none entered the auditorium where the observers stood in front of the fireproof partition, in perfect safety, though somewhat inconvenienced by radiated heat.

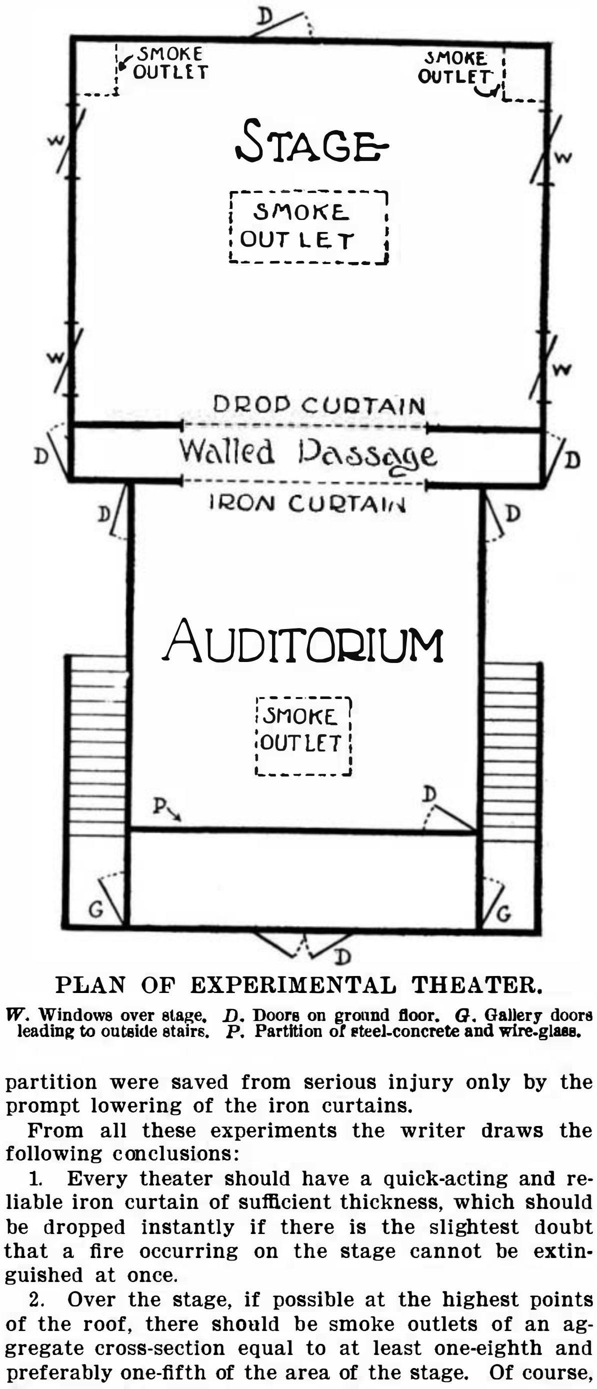
Fourth Experiment.—The smoke outlet over the auditorium remained closed, but the stage outlets were opened in the course of the conflagration, partly by hand and partly by the burning of combustible fastenings. The iron curtain was lowered after the fire was started. The observers stood in front of the partition and suffered little from heat, as the curtain cut off the radiation before the fire had made much progress. The other phenomena were the same as in the third experiment.

These results appeared to confirm the conclusions to which the committee had been led by the preliminary experiments, namely, that the opening of the outlets over the stage was the all important means of protection and that it should be accomplished as promptly as possible and even before the lowering of the iron curtain, in order to prevent the strong indraft of smoke and flame through the narrowed opening below the descending curtain. (See second experiment.)

Some of the spectators, however, dissented from this view. They pointed out that the opening of the outlets would fan the flames and thus precipitate a panic in the audience if the fire curtain were not down, and furthermore that in an actual theater conflagration all the doors of stage and auditorium would be immediately opened and the inrush of air would drive the smoke into the auditorium. These objections led to the making of the fifth experiment.

Fifth Experiment.—The outlet over the auditorium remained closed while the outlets over the stage and all the doors of both stage and auditorium were opened at the beginning of the conflagration. The iron curtain was not immediately lowered.

The result fully sustained the objections above quoted. The outlets carried off the smoke of the incipient fire, but as soon as the doors were opened smoke, flame, and burning fragments rushed into the auditorium so fiercely that those of the observers who had rashly taken their stand in front of the fireproof partition were saved from serious injury only by the prompt lowering of the iron curtains.



PLAN OF EXPERIMENTAL THEATER.

W. Windows over stage. *D.* Doors on ground floor. *G.* Gallery doors leading to outside stairs. *P.* Partition of steel-concrete and wire-glass.

From all these experiments the writer draws the following conclusions:

1. Every theater should have a quick-acting and reliable iron curtain of sufficient thickness, which should be dropped instantly if there is the slightest doubt that a fire occurring on the stage cannot be extinguished at once.

2. Over the stage, if possible at the highest points of the roof, there should be smoke outlets of an aggregate cross-section equal to at least one-eighth and preferably one-fifth of the area of the stage. Of course, the path of the smoke toward these outlets must not be obstructed in any way. It should be possible to open these outlets from the stage and also from at least one other point, easily accessible and protected from smoke and flame. There should be regular drills in the manipulation of the opening apparatus. Automatic opening by pressure of combustion gases, combustion fastenings or connection with the iron curtain is not advisable. The opening of the outlets necessarily fans the flames and the proper moment to effect it should be left to the discretion of the firemen on the stage.

3. A sprinkling apparatus over the stage is useful in some cases. It should not be automatic, but should also be controlled by the firemen.

4. Gas lights are almost sure to be extinguished in a conflagration, and candles and kerosene lamps are unreliable. The safety illumination is best furnished by powerful incandescent electric lights, independent of the general lighting system and supplied by individual accumulators. All exits of auditorium and stage should be marked by red lights of this character.

5. Generally speaking, the character of the ordinary

* Abstract of a paper read before the Hamburg Society of Architects and Engineers, December 15, 1905, by Fire Commissioner Westphalen.

* Not more so, however, than the fire in the Iroquois Theater in Chicago. —Trans.